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ABSTRACT

Presented is a report of a program of the American Society for Metals, designed to introduce materials science principles via solid state chemistry into high school chemistry courses. At the time of the inception of this program in the mid-sixties, it was felt that high school students were not being adequately exposed to career opportunities in the materials field. Consequently, a 64-page student text, teacher's guide, reference book, visual aids, and kits for laboratory experiments were developed. It has been estimated that the Solid State Structure and Reactions program has reached over 100,000 students through 900 reachers, The materials are still available at a low cost. (CP)

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INTRODUCTION OF MATERIALS SCIENCE THROUGH SOLID STATE CHEMISTRY

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INTRODUCTION OF MATERIALS SCIENCE THROUGH SOLID STATE CHEMISTRY

I. The Problem

Metallurgy, metallurgical engineering and their offspring, materials science and materials engineering, are seldom more than vaguely understood terms among young people. When their high school principal introduces a noted metallurgist to them as a meteorologist, the slip goes by unnoticed.

This is an unsatisfactory state of affairs from the standpoints of our national well-being and of the career potentials of the students. The looming materials and energy shortages facing our country have already resulted in awareness that too few qualified graduates in these branches of minerals engineering are being trained and that the discrepancy between need and availability will, in all likelihood, increase in the years to come.

High school curricula are, of course, limited in what exposures are made available to the student. It is not feasible to review, even briefly, all the branches of science and engineering. Attempts to give a fair audience to a substantial number of disciplines on career day programs usually result in only a modicum of success.

Accordingly, it was recognized that if an increased awareness of the career opportunities to be had in the materials field were to be developed within the high school curriculum, it must be by penetration into an existing part of that curriculum.

Chemistry, because of the strong dependence of materials science and engineering on chemical principles and of the fact that essentially all students of engineering bent tend to take chemistry, seemed to be the logical place.

Unfortunately, a significant gap existed here in that high school chemistry texts and courses were almost exclusively devoted to reactions in the fluid state while much of materials engineering and science depends upon reactions in the solid state.

II. An Approach to a Solution

In the mid sixties the American Society for Metals Foundation for Education and Research at the suggestion of and guidance by Professor Earl R. Parker of the University of California at Berkeley undertook a program designed to introduce materials science principles via solid state chemistry into high school chemistry courses. This program was called "Solid State Structure and Reactions" (SSSR) and consisted of the following:

A. Materials

1. A student text. This is a 64 page booklet containing an easily readable treatment of materials science concepts. It also contains questions and problems, an appendix developing some of the mathematical details, a glossary of about 150 terms, a list of selected readings, instructions for four laboratory experiments and an index.

The partial table of contents listed below reveals much about the material covered.

Introduction

Nature of Solids
- Solid Solutions
- Non-Metallic Solids
- The Atomic Level of Solid Materials
- The Crystalline Nature of Solids
  - Allotropic Change
  - Plastic Flow
- Electrical Properties

Energy Consideration
- Interparticle Forces and Distances
- Interparticle Distance, Arrangement, Motion and Energy
- Energy and Random Motion

Bonding in Solids
- Primary Interatomic Bonds
- Secondary Interatomic Bonds
- Atomic Structure and Bond Type

Bonding, Structure and Properties
- Properties Related to Secondary Bonds

Reactions in Solids
- Chemical Reactions in Solids
- Diffusion in Solids

Phases in Solids

2. Teacher's guide. This booklet offers suggestions on the use of the text, visual aids, laboratory kits, demonstrations, special student activities, additional questions and problems with answers and suggestions for quiz questions.

3. Reference book. The September 1967 issue of Scientific American was a special issue on materials science. A book, "Materials" was issued as a reprint and this is provided to teachers as a reference.

4. Visual aids. A set of twelve color overhead projector transparencies is included to illustrate a number of solid state phenomena including solid solution, allotropy, diffusion, precipitation from solid solution, transofrmation reactions and plastic flow.

5. Kits for laboratory experiments. Instructions for five laboratory experiments are given in the student text. Two kits were designed to aid in conducting these experiments.

   a. Crystallography kit.

      This kit consists of styrofoam balls of different sizes and connectors to aid in the examination of different crystal structures and illustrate slip planes, interstice size and number and coordination concepts.

   b. Allotropy kit.

      This kit contains steel wires, a file and a magnet to aid in the study of the effect of thermal treatment on the allotropic behavior of iron and the resultant properties.

B. Method of operation

It was recognized that direct personal contact by materials experts with teachers and educational administrators could be most helpful. Accordingly, the program was introduced at the

local level through the numerous chapters of the American Society for Metals. Representatives of the chapters made the science coordinators and teachers aware of the program and offered their assistance in carrying it out. Frequently, field trips to materials processing operations were arranged to supplement the classroom and laboratory activities.

C. Results

The Solid State Structure and Reactions program reached over 100,000 students through approximately 900 teachers with the help of 58 ASM chapters. The teachers have taught the material either as a supplementary unit or incorporated parts of the program into their science units.

Some progress has been made in developing an interest among textbook publishers to include an appreciable amount of solid state chemistry in their chemistry texts.

Originally, the ASM Foundation for Education and Research provided funds to make text and other materials available to high schools at no cost. This could not continue indefinitely and at this time the materials are available for purchase at a modest price.